ORIGINAL ARTICLE

COMPARISON OF PERINATAL OUTCOME OF GROWTH RESTRICTED FOETUSES WITH NORMAL AND ABNORMAL UMBILICAL ARTERY DOPPLER WAVEFORMS

Azmat Ali, Iffat Ara*, Ruqqiya Sultana, Faiza Akram, Muhammad Jehan Zaib
Department of Radiology, Ayub Medical College, Abbottabad, *Combined Military Hospital, Muzafarabad, Pakistan

Background: Intrauterine growth restriction (IUGR) is a complex problem. It is notorious but a difficult diagnosis. The perinatal mortality can be reduced when the results of umbilical artery Doppler are made available to clinicians to help them intervene more timely and appropriately. This study aimed to compare perinatal outcome of growth restricted foetuses with normal and abnormal umbilical artery doppler waveforms. **Methods:** This cross-sectional descriptive study was conducted in the radiology department of Mother and Child Health (MCH), Pakistan Institute of Medical Sciences (PIMS), Islamabad from March 2007 to March 2008. A total of 100 pregnant women with growth restricted foetuses were studied with umbilical artery Doppler ultrasound. Fifty women had normal umbilical artery Doppler waveform and the umbilical artery Doppler wave-form was compromised (either absent or reversed) in the 50 pregnancies. These patients were followed up and the perinatal outcomes were recorded and compared. **Results:** Premature delivery was recorded in 14% in the normal group and 96% in the abnormal group. The number of babies with low birth weight was more in the abnormal group. The neonatal intensive care (NICU) admissions were significantly increased in the abnormal group (82%). The incidence of intra-ventricular haemorrhage was more (18%) in the abnormal umbilical artery Doppler group as compared to normal group (06%). Perinatal deaths were three times more in the abnormal umbilical artery Doppler group as compared to normal. The difference in the perinatal outcome of both group is statistically significant (p=.0001). **Conclusion:** There is a strong relationship between pregnancy outcome in IUGR babies and abnormal uterine artery doppler waveform (Absent or reversed).

Keywords: Intrauterine growth restriction, Umbilical artery Doppler waveform, perinatal outcome
J Ayub Med Coll Abbottabad 2014;26(3):344–8

INTRODUCTION

The overall incidence of intrauterine growth retardation (IUGR) growth restriction varies in different studies but is usually between 3% and 10% of all births.[1] The growth restricted foetuses are vulnerable to a number of perinatal complications and need monitoring and evaluation using different parameters. High perinatal mortality has been reported in association with the finding of absent end diastolic flow velocities in the umbilical arteries.[2]

IUGR foetuses are frequently described as symmetric or asymmetric in term of their body proportion. Symmetrically small foetuses are usually associated with factors that directly impair the intrauterine growth potential of foetus (i.e., Chromosomal abnormalities, viral infections etc.) while asymmetric growth restriction is classically associated with utero-placental insufficiency.[3] The most common cause for uteroplacental insufficiency is pregnancy induced hypertension. The prevalence of IUGR in Pakistan is 25%.[4]

The preferred radiological examination for evaluating IUGR is ultrasonographic examination. These include grey scale assessment of parameters of foetal biometry (BPD, FL, AC, HC and EFW). The foetal growth surveillance is by Doppler study of the umbilical artery and vein. The sonographic criteria for diagnosing IUGR include a high ratio of femoral length to abdominal circumference, (AC) and a high ratio of head circumference to AC, with an unexplained oligohydramnios.

The AC measurement is the best single measurement to assess foetal growth because, in growth curtailment, the liver is virtually always affected.

The rationale for performing a Doppler study in IUGR is that many cases of growth restriction are thought to be associated with small vessel disease in foetoplacental or uteroplacental circulation. Numerous Doppler criteria have been proposed for diagnosing IUGR. The most important among these is the S/D (systolic, diastolic ratio).An S/D ratio of greater than 3 after 30 weeks of gestation is abnormal. Decreased foetal weight with decreased amniotic fluid volume and presence of maternal hypertension are good predictors of IUGR.2,3

Although it is not possible to reverse IUGR, some treatment may help slow or minimize the effects. The importance of our study is to draw attention of the clinicians to the importance of umbilical artery Doppler study in the management of IUGR and its role in decision making regarding the further course of the pregnancy, i.e., timing and mode of delivery. Timely

intervention can help in the better perinatal outcome of the pregnancy.

MATERIAL AND METHODS

The study was conducted in the radiology department of maternal and child health (MCH), Pakistan Institute of Medical Sciences (PIMS) Islamabad from March 2007 to March 2008. Cases were sampled according to inclusion and exclusion criteria from the referred cases for obstetrical ultrasound to this department. All third trimester singleton pregnancies with IUGR attending our radiology department for Doppler assessment were included in the study. All the diabetic pregnant mothers, mothers with chronic ailments and foetuses having congenital anomalies were excluded.

Informed consent was taken from all the pregnant ladies included in the study. The pregnancies were dated by a combination of last menstrual period and the first trimester booking dating scan. The diagnosis of IUGR was made clinically and confirmed subsequently on ultrasound, when foetal abdominal circumference was below 5th centile and estimated foetal weight was also below 5th centile for the gestational age. A detailed anomaly scan was performed on all foetuses and dysmorphic foetuses were excluded from the study. Mothers with chronic hypertension, diabetes and other chronic medical diseases were excluded from the study.

All women in the study were subjected to umbilical Doppler study. The spectral waveform was analysed. The normal, low diastolic velocity, absent or reversed diastolic component were noted. Besides analysing the spectral waveforms, Doppler measurements, (PI, RI, S/D ratio) and other growth parameters were also noted, in addition to liquor and placental grading. Total sample was split in to 2 groups with 50 in each group. The women were divided into two groups depending on their umbilical Doppler findings. The group-1 (n=50) comprised of women with IUGR foetuses with normal umbilical artery waveform. The other group-2 (n=50) included women with IUGR foetuses who had absent or reversed diastolic flow in the umbilical artery.

Outcomes data were collected which included diagnosis to delivery interval, gestational age at birth, admission to NICU, duration of NICU stay, duration of hospital stay and morbidity and mortality if any. The results then were analysed using SPSS-10.

RESULTS

The mean age of patient in the group I ranged from 28±2.7 years and in group-2 ranged from 26±3.1 years which was comparable. Thirteen women in group I and 15 in group-2 were pregnant for the first time. Five patients in group-2 had intrauterine deaths in previous pregnancies. Various parameters of group-I and II are shown in table-1.

Absent end diastolic flow/ reversed end diastolic flow was diagnosed at gestational age of 28±0.23 weeks in group II. Out of fifty patients in group-II, 38 patients had absent end diastolic flow and 12 had reversed end diastolic flow.

In group-I all patients had normal umbilical artery Doppler waveform. In patients with reduced end diastolic flow (REDF) the delivery was conducted within few hours, however in patients with absent end diastolic flow (AEDF) pregnancy could be prolonged for a few days with intensive foetal monitoring. This was helpful in women where time was needed to administer betamethasone or in those women who were remote from the threshold of maturity that is around 26 week's gestation until 30 weeks. Women in group I with IUGR and normal umbilical artery Doppler waveform were delivered at 35±2.8 weeks.

The perinatal outcome was studied under the following major outcome parameters: Premature delivery, birth weight, NICU admissions/length of stay, intra-ventricular haemorrhage (IVH)

In our study premature delivery was more in the group-2 patients as compared to the group-1. Similarly NICU stay was more in the group-2 patients with abnormal UA doppler waveform, as compared to the group-1. Difference in the birth weight of two groups was statistically significant. (p=0.0001). NICU admissions were 24% in the normal UA doppler and 82% in the abnormal UA doppler group. The incidence of IVH was more in the group-2 patients as compared to the group-1 patients. Perinatal death was recorded in 9 patients (18%) of group-2 and 3%) of group-1. As compared to AEDF, foetuses with REDF had more morbidity and mortality.

Table-1: Comparison of outcome data of normal and abnormal UA doppler waveform group

Parameter	Normal UA Doppler	Abnormal UA Doppler
Premature Delivery	7 (14%)	48 (96%)
Birth weight	(1680±259 Grams)	(742±126 Grams)
NICU admission	12 (24%)	41 (82%)
IVH	2 (4%)	11 (22%)
Perinatal death	3 (6%)	9 (18%)

Figure-1: Absent end diastolic flow in UA Doppler waveform

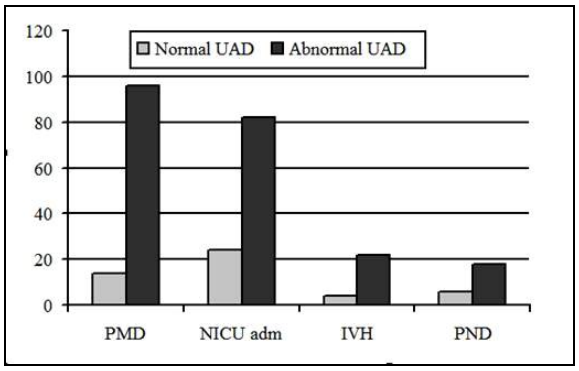

Figure-2: Bar representation of the outcome data of both groups

PMD=Premature delivery, NICU adm= NICU admissions, IVH=Intraventricular hemorrhage, PND=Perinatal deaths, UAD=umbilical artery Doppler waveform

DISCUSSION

Development in field of Doppler has helped obstetricians in making decision especially about the growth restricted foetuses. The controversy exists as to which foetal blood vessel is best for deciding pregnancy continuation or termination. Evidence suggests that umbilical artery Doppler is fairly good for assessment of the growth restricted foetuses and decision about pregnancy, yet use of other vessels like middle cerebral artery (MCA) or ductus venosus, may give additional help in decision-making.[5] Ductus venosus waveforms are said to be time consuming and all sonographers may not be able to perform it properly. Hence experience and skill of sonographer is required to perform the Ductus venosus and all venous assessment. It provides important information about the preload situation of the foetal cardiac system. Changes in MCA territory may indicate about the advanced stages of foetal hypoxia. For all these reasons, umbilical artery Doppler plays a pivotal role in clinical settings.

Good uteroplacental circulation is essential for progress and normal outcome of pregnancy which needs normal optimal uteroplacental development. IUGR is associated with high perinatal mortality, morbidity and impaired neurodevelopment. Detection of the compromised IUGR foetus is the main objective of sonographic assessment so that timely intervention can be performed and this is the main purpose of antenatal care.[6]

Doppler velocimetry differentiates between normal and altered blood flow in the umbilical artery and detects changes in the placental resistance. This non-invasive technique evaluates abnormal foetal haemodynamics which can result in abnormal pregnancy outcome. It has been shown by various workers that perinatal morbidity and mortality were significantly high in small for gestational age babies with abnormal umbilical artery Doppler studies as compared with those with normal studies.[7–9] These findings are in accordance with our study results because we also found that perinatal morbidity and mortality was significantly increased with in the abnormal group having AEDF or REDF as compared to the pregnancies with normal flow in the diastole. An association between normal and abnormal umbilical artery velocity waveform in growth restriction and its outcome predictions have been reported by various studies.[10,11]

All infants whose birth weight is below the 10th percentile are not exposed to a pathologic process in utero but some are constitutionally small and healthy. It is a challenge to differentiate the foetus pathologic growth restriction and hence at risk for perinatal complications from constitutionally small but healthy foetus.[12] This is here that the role of umbilical artery Doppler velocity waveform becomes important to play a role and has been shown to lead to significant reduction in number of antenatal admissions and induction of labour.

Gudmundsson *et al* concluded that in normal pregnancies the three indices; S/D. PI and RI decrease with advancing gestation in umbilical artery. But in IUGR first there is decreased diastolic flow in the umbilical artery due to increase in the resistance that occurs in small arteries and arterioles of the tertiary villi. This raises the S/D ratio, PI and RI of the umbilical artery. As the placental insufficiency worsens, first there is decrease in diastolic flow, then it becomes absent, and in advances stages it reverses. Some foetuses have decreased diastolic velocity that remains constant with advancing gestation and never becomes absent or reversed which may be due to a milder form of placental insufficiency.[13]

Various studies have confirmed the clinical benefits of umbilical artery doppler velocimetry in high risk pregnancies, where this method has been compared with conventional NST, BPP and ultrasound foetometry. Doppler studies also allow more precise targeted prenatal monitoring and obstetric interventions, as pathological Doppler findings may be detected several hours to days before any abnormality, in cardiotocographic tracings.[14, 16]

There is variability in time between the detection of AEDF flow in the umbilical artery and occurrence of abnormal foetal heart rate patterns varies greatly. This causes ambiguity in the subsequent decision-making. The magnitude of the problem considerably increases in cases where extreme prematurity and imminent foetal asphyxia are coexistent.

The result of our study clearly demonstrates the efficacy of Doppler in assessing foetal outcome. The perinatal mortality in women with AEDF/REDF was 18%, in contrast to 6% in women with normal

Doppler findings. The values for other outcome parameters namely premature devilry, low birth weight, need for NICU admissions and neonatal intraventricular haemorrhage, were all higher in foetuses with AEDF/REDF. The results are comparable to many previous studies.[16–20]

In a study from Italy by Cosmi *et al*[21] reported that neonatal death was increased in foetuses with umbilical artery reversed flow ($p<.05$). They also concluded that foetuses with idiopathic growth restriction, low birth weight, umbilical artery reversed flow and ductus venosus absent or reversed flow, had an increased perinatal morbidity and mortality.

Schwarze *et al*,[22] analysed 74 growth-restricted foetuses between 24 to 34 weeks of gestation, concluded that abnormal venous Doppler waveforms in preterm IUGR foetuses with ARED flow had strong association with adverse foetal and perinatal outcomes before 32 weeks of gestation. Gerber *et al*. studied[23] the short-and long-term morbidity and mortality among children associated with abnormal umbilical artery Doppler and concluded that IUGR associated with umbilical Doppler AEDF/REDF does not show any benefit from an expectant management in terms of long-term morbidity, in addition to being associated with an increased perinatal loss.

The decision whether to continue with pregnancy or to deliver foetuses in the presence of AEDF is a complicated issue for the treating obstetricians. However, pregnancy could be continued even in the presence of AEDF for approximately 10 days but it should be done with intensive foetal surveillance. This can buy precious time for administration of steroids for foetal lung maturity and also can give time for foetus to gain weight. This time also enables for shifting of the patient to a tertiary centre where proper neonatal care can be provided.

Doppler velocimetry of the umbilical artery is in common use for foetal surveillance in high-risk pregnancies.[24,25] These results of these studies are in accordance with our study which also concluded that the presence of abnormal flow in the umbilical artery correlates with foetal growth restriction and increased neonatal morbidity and mortality.

Our study recommends the use of Doppler in cases of IUGR foetuses. If end diastolic flow is normal, repeat Doppler can be performed regularly with foetal surveillance by NST and BPP, as the women with normal Doppler findings have very low perinatal morbidity and mortality. In cases with AEDF/REDF, if foetus is salvageable and neotal-nursery facilities are adequate, it is wise to deliver the baby for a better perinatal outcome. Delivery can be delayed by 1–2 weeks if desired, with very intensive foetal surveillance in cases of AEDF, but immediate delivery is advised in cases where REDF sets in.

CONCLUSION

Our study and other recent studies have found that there is a strong relationship between pregnancy outcome in IUGR babies and abnormal UA Doppler waveform (Absent or reversed), therefore sonographic surveillance of high-risk foetuses results in a decreased in foetal death and morbidity when compared to traditional surveillance (non-stress test). For this reason, all foetuses with suspected intrauterine growth restriction should undergo umbilical artery Doppler evaluation.

REFERENCES

1. Middleton WD, Kurtz AB, Hertzberg BS. Fetal growth and well-being. In: Middleton WD, Kurtz AB, Hertzberg BS (eds.) Ultrasound: The Requisites, 2nd ed. St Louis: Mosby; 2004.p. 330–41.
2. Gudmundsson S, Tulzer G , Huhta JC, Marsal K. Venous Doppler in the foetus with absent end diastolic flow in the umbilical artery. Ultrasound Obstet Gynecol 1996;7:262–7.
3. Disorders of placentation. In: Baker PN, Kenny L, editors. Obstetrics by ten teachers. 18th ed. London: Hodder Arnold; 2006.p. 156–70.
4. Zafar H, Naz M, Fatima U, Irshad I. Frequency of IUGR in pregnancy induced hypertension. J Univ Med Dent Coll 2012;3(2):8–13.
5. The Investigation and Management of the Small-for-Gestational-Age Foetus (31)-2002 RCOG Guidelines. 2002. Availabel at: http://www.gestation.net/RCOG%20Small_Gest_Age_Foetus_No31.pdf
6. Lakhkar BN, Rajagopal RV, Gourisankar PT. Doppler prediction of adverse perinatal outcome in PIH and IUGR. Indian J Radiol Imaging 2006;16:109–16.
7. Rochelson B, Schulman H, Fleischer A, Farmakides G, Bracero L, Ducey J, *et al*. The clinical significance of doppler umbilical artery velocimetry in the small for gestational foetus. Am J Obstet Gynecol 1987;156:1223–6.
8. Burke G, Stuart G, Crowley P, Scanaill SN, Drumm J. Is intrauterine growth retardation with normal umbilical artery flow is a benign condition?. BMJ 1990;300:1044–5.
9. Craigo SD, Beach ML, Harvey-Wilkes KB, D'Alton ME. Ultrasound predictors of neonatal outcome in intrauterine growth retardation. Am J perinatal 1996;13:465–71.
10. Berkowitz GS, Chitkara UJ, Rosenberg J, Cogswell C, Walker B, Lahman EA, *et al*. Sonographic estimation of fetal weight and doppler analysis of umbilical artery velocimetry in the prediction of intrauterine growth retardation: A sprospective study. Am J Obstet Gynecol 1988;158:1149–53.
11. Rohelson B, Bareere LA, Port J, Farmakides G. Diagnosis of intrauterine growth retardation as two-step process with morphometric ultrasound and doppler artery velocity. J Reprod Med 1992; 37:925–9.
12. Devendra A, Desai SK, Sheth PN, Prema K. Significance of umbilical artery velocimetry in perinatal outcome of growth restricted foetuses. J Obstet Gynecol India 2005;55:138–43.
13. Gudmundsson S, Marsal K. Umbilical artery and uteroplacental blood flow velocity waveforms in normal pregnancy- a cross- sectional study. Acta Obstet Gynecol Scand 1988;67:347–54.
14. Tyrrell SN, Lilford RJ, Macdonald HN, Nelson EJ, Porter J, Gupta JK. Randomized comparison of routine vs highly selective use of Doppler ultrasound and biophysical scoring to investigate high-risk pregnancies. Br J Obstet Gynaecol

1990;97:909–16.
15. Almstrom H, Axelsson O, Cnattingius S, Ekman G, Maesel A, Ulmsten U, *et al*. Comparison of umbilical-artery velocimetry and cardiotocography for surveillance of small-for-gestational-age foetuses. Lancet 1992;340:936–40.
16. Chauhan SP, Reynolds D, Cole J, Scardo JA, Magann EF, Wax J, *et al*. Absent or reversed end-diastolic flow in the umbilical artery: outcome at a community hospital. J Miss State Med Assoc 2005;46:163–8.
17. Sezik M, Tuncay G, Yapar EG. Prediction of adverse neonatal outcomes in preeclampsia by absent or reversed end-diastolic flow velocity in the umbilical artery. Gynecol Obstet Invest 2004;57:109–13.
18. Kurkinen-Raty M, Kivela A, Jouppila P. The clinical significance of an absent end-diastolic velocity in the umbilical artery detected before the 34th week of pregnancy. Acta Obstet Gynecol Scand 1997;76:398–404.
19. Tannirandorn Y, Phaosavasdi S. Significance of an absent or reversed end-diastolic flow velocity in Doppler umbilical artery waveforms. J Med Assoc Thai 1994;77:81– 6.
20. Battaglia C, Artini PG, Galli PA, D'Ambrogio G, Droghini F, Genazzani AR. Absent or reversed end-diastolic flow in umbilical artery and severe intrauterine growth retardation. An ominous association. Acta Obstet Gynecol Scand 1993;72:167–71.
21. 23.Cosmi E, Ambrosini G, D'Antona D, Saccardi C, Mari G. Doppler, cardiotocography and biophysical profile changes in growth-restricted foetuses. Obstet Gynecol 2005;106:1240–5.
22. Schwarze A, Gembruch U, Krapp M, Katalinic A, Germer U, Axt-Fliedner R. Qualitative venous Doppler flow waveform analysis in preterm intrauterine growth-restricted foetuses with ARED flow in the umbilical artery-correlation with short-term outcome. Ultrasound Obstet Gynecol 2005;25:573–9.
23. Gerber S, Hohlfeld P, Viquerat F, Tolsa JF, Vial Y. Intrauterine growth restriction and absent or reverse end-diastolic blood flow in umbilical artery (Doppler class II or III): A retrospective study of short- and long-term fetal morbidity and mortality. Eur J Obstet Gynecol Reprod Biol 2006;126:20–6.
24. Alfirevic Z, Neilson JP. Doppler ultrasonography in high-risk pregnancies: systematic review with meta-analysis. Am J Obstet Gynecol 1995;172:1379–87.
25. Pattison RC, Odendaal HJ, Kirsten G. The relationship between absent end-diastolicb velocities of the umbilical artery and perinatal mortality and morbidity. Early Hum Dev 1993;33:61–9.

Address for correspondence:

Dr. Azmat Ali, Radiology Department Ayub Teaching Hospital, Abbottabad, Pakistan.
Cell: +92-334-5400211
Email: drazmat772@gmail.com